

VIBRATING DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation of PCT/JP2015/066141 filed Jun. 4, 2015, which claims priority to Japanese Patent Application No. 2014-117784, filed Jun. 6, 2014, the entire contents of each of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to a vibrating device that includes a vibrating body that vibrates when a drive signal is applied to a vibrator extending and contracting in a planar direction.

BACKGROUND

[0003] In recent years, a vibrating device which makes a user feel a “push” of a key by transmitting a vibration when the user touches the key on a touch panel keyboard has been proposed.

[0004] For example, Patent Document 1 discloses an electronic device which includes a touch panel sensor which detects a user's touch on a key, a piezoelectric bimorph element (piezoelectric body) which is made of piezoelectric ceramics, and vibration control means (drive circuit) which applies an alternating-current drive signal to the piezoelectric bimorph element. Both ends of the piezoelectric bimorph element are held by support members, and a vibrated body (diaphragm) is provided at a center of the piezoelectric bimorph element.

[0005] The electronic device of Patent Document 1 transmits a vibration to a user via the connected vibrated body (diaphragm) by applying an alternating-current drive signal to the piezoelectric bimorph element to vibrate. Thus, the electronic device of Patent Document 1 gives a tactile feedback to the user and makes the user feel a “push” of a key.

[0006] Patent Document 1: Japanese Patent Application Laid-Open No. 2005-303937,

[0007] However, the drive circuit that applies a drive signal frequently causes electromagnetic noise in the electronic device in Patent Document 1. Further, the electronic device of Patent Document 1 includes a sensor which detects a user's touch on a key.

[0008] Hence, the sensor is likely to cause an error operation due to the electromagnetic noise caused by the drive circuit in the electronic device of Patent Document 1.

SUMMARY OF THE INVENTION

[0009] It is therefore an object of the present disclosure to provide a vibrating device that can shield electromagnetic noise caused by a drive circuit, and prevent an error operation of a sensor.

[0010] A vibrating device according to the present invention includes a sensor; a vibrator which extends and contracts in a planar direction when a drive signal is applied to the vibrator; a drive circuit; and a vibrating body at least part of which is in contact with the vibrator, and that includes a conductor. The drive circuit applies a drive signal to the vibrator, and the vibrating body vibrates according to the drive signal. Further, the conductor is connected to a reference potential of the sensor.

[0011] Furthermore, in the vibrating device according to the present invention, the conductor is arranged between the sensor and the drive circuit.

[0012] Even in this configuration, too, the drive circuit that applies the drive signal causes electromagnetic noise. However, the conductor is arranged between the sensor and the drive circuit, and is connected to the reference potential of the sensor. Hence, the conductor shields the electromagnetic noise caused by the drive circuit.

[0013] Consequently, the vibrating device disclosed herein can prevent an error operation of the sensor.

[0014] Further, the disclosed vibrating device may employ the following aspect. That is, according to this aspect, the sensor may detect a touch operation, the drive circuit may apply a drive signal to the vibrator when the sensor detects the touch operation, and the vibrating body may be fixed in a state where a bending stress is produced.

[0015] According to this configuration, the sensor detects a user's touch on a key when the user performs a touch operation. Thus, the drive circuit applies the drive signal to the vibrator, and the vibrator extends and contracts in a planar direction. The vibrating body produces the bending stress, so that the vibrating body efficiently vibrates in response to extension and contraction of the vibrator. In this case, the vibrating device gives a tactile feedback to the user by transmitting the vibration to the user.

[0016] In addition, according to one aspect, the vibrating body may be fixed to the vibrator in a state where the vibrating body is curved in a direction orthogonal to a principal surface of the vibrator, or according to one aspect, the vibrating body may have a surface that is in a curved shape in a state where the vibrating body is not fixed to the vibrator, and produce a bending stress when fixed to the vibrator such that the surface becomes flat.

[0017] Further, according to one aspect, the sensor, the vibrating body and the vibrator may be stacked.

[0018] Furthermore, according to one aspect, the sensor may detect a touch on a touch panel attached to the vibrating body.

[0019] Still further, the vibrator can be made of a chiral polymer. When polylactic acid is used for the chiral polymers, it is possible to realize the vibrating device whose almost entire surfaces seen from a front view have high translucency by using a material having translucency for other components, too. Further, the chiral polymer can be poly-L-lactic acid (PLLA). The PLLA does not have pyroelectricity, and therefore is not influenced by a change in an ambient temperature.

[0020] Consequently, a strength of a vibration of the vibrating device is not changed by a change in an atmospheric temperature, heat generation of an electronic device or a change in a temperature caused by a touch of a finger. Consequently, it is possible to provide a stable tactile feedback.

[0021] In one aspect, the disclosed vibrating device includes a sensor; a vibrator at least part of which includes a conductor and which extends and contracts in a planar direction when a drive signal is applied to the vibrator; and a drive circuit. The drive circuit applies a drive signal to the vibrator to vibrate. Further, the conductor is connected to a reference potential of the sensor. Furthermore, in the vibrating device of a tactile presenting device according to the present invention, the conductor is arranged between the sensor and the drive circuit.